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ABSTRACT

Undergraduate students who were given specific instructions to form mental images while reading a text passage containing spatial information scored significantly higher than the control group on a drawing posttest. Significant correlations also resulted between the test scores and both reading time and use of imagery. The use of imagery instructions seems to influence the quality of the mental representation and therefore the ability to construct more accurate drawings of the information described in text. Drawing an object from memory is a task that requires the generation of an image in the working memory and reflects the quality of the mental representation. Thus, the use of imagery instructions can be a valuable strategy for learning when the information contains important spatial information. (25 references) (Author/DB)

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The Effect of Mental Imagery on a Constructional Task

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The Effect of Mental Imagery on a Constructional Task

Abstract

Undergraduates who were given specific instructions to form mental images while reading a text passage containing spatial information scored significantly higher than the control group on a drawing posttest. Significant correlations also resulted between the test scores and both reading time and use of imagery. The use of imagery instructions seems to influence the quality of the mental representation and therefore the ability to construct more accurate drawings of the information described in text. Drawing an object from memory is a task that requires the generation of an image in the working memory and reflects the quality of the mental representation. Thus, the use of imagery instructions can be a valuable strategy for learning when the information contains important spatial information.

Introduction

There is general agreement that images are manipulated and transformed by the working memory for tasks requiring spatial, size judgments, or visual information (Kosslyn, 1980, 1984). As a specialized representational system, mental imagery serves to reduce the information processing burden by implicitly representing spatial information in a way that allows the greatest amount of information to be held in working memory at one time (Gagne, 1985). The dual-trace theory of Bower (Bower & Hilgard, 1981) recognizes imagery as a technique to maximize learning in minimal time. Thus, images are valuable accommodations to the limited capacity of the working memory which preserve or require spatial information. In addition, the induction of imagery may be important when structural information needs to be learned.

Shepard (1978) feels that mental imagery has an important function for high-level thinking where concrete representations merge with related associative processes at abstract conceptual levels. In problem solving, experts form sophisticated mental representations of problem components (Chi, Glaser & Rees, 1981; Gilhooly, 1989). Mental imagery, as a type of physical mental model, is also important to the formation of mental representations (Johnson-Laird, 1983).

Held in the visual-spatial component of the working

memory, mental images are the result of an active process which is very similar to an attentional state (Farah, 1989). Paivio (1972) notes that in associative learning, imagery is more effective than a verbal mediator and is less susceptible to interference than verbal processes; these are conditioned sensations where appropriate words act as conditioned stimuli or as constructs that the learner actively generates. Imagery use may be an organizational strategy for structuring inputs into units having dominant spatial properties (Di Vesta & Ross, 1978).

Since it can be used to promote information processing, the use of imagery has been demonstrated to be an important factor in learning and retention (Mayer,' 1987). As a form of elaboration, it helps form associations (Weinstein & Mayer, 1986). Edelstein (1981) reported that elaboration strategies, in particular visually oriented mnemonics, facilitated information integration and subsequent higher-order learning of abstract concepts.

Many researchers have shown that performance on memory tests is significantly improved when the subjects receive instructions to form mental images that relate to the learning task at hand. Shepard and Podgarny (1978) report that giving explicit instructions to subjects helps ensure internalization of information which will lead to better test performance. In these, as well as the present study,

the imagery instructions are used as an elaboration strategy intended to facilitate the formation of new associations based on prior knowledge. In these studies the task and measure are verbal in nature while the mediating mechanism is not.

Imagery instructions may cause subjects to attend to details of structural information resulting in the formation of a more complete mental representation. If there is a more complete mental representation due to the orienting quality of the imagery instructions and the increased attention to structural details, it should be evident when a constructional task is used as a criterion measure, such as drawing a complex object as described in text.

Farah (1984) identified six tasks that are relevant to assessing imagery ability. One of these tasks, a constructional task (drawing), is related to the generation of mental images. Such a task requires was used in the present study not to assess imagery ability. A drawing task was used since it requires the subjects to generate an image in the visual buffer of short term memory before they can correctly reproduce the anatomical structures and symbols with respect to each other. This is the visual-to-motor translation process described by Farah (1984) in her extension of Kosslyn's (1980) imagery model. Also, Paivio (1969) states that imagery is specialized for spatial

representations. Thus, those who received instructions to image should be favored in such a task. The present study was designed to test this hypothesis.

Method

The sample for the study was drawn from student volunteers recruited for this specific purpose. The 166 subjects were all Penn State undergraduates. However, it was assumed that all subjects were familiar with the basic structure and pumping function of the heart. To ensure that the subjects were novices in the content area of the study, the students were screened for prior knowledge of the heart function, i.e. pre-med or physiology majors were asked to participate in other graduate research. An arrangement was made to compensate all participants with course credit.

Procedure

Classrooms were scheduled for small group testing sessions. Subjects were randomly assigned to groups and the data were recorded in such a manner as to ensure confidentiality. Each subject received a packet of material upon entering the room. The packet contained the informed consent form, an explanation of the study, a text-based treatment booklet, a time-recording sheet, a post-treatment questionnaire, and the drawing posttest.

The subjects were given an orientation to the procedures and the chance to ask any questions of the investigator. Names were not recorded on the test instruments or answer sheets. Prior to reviewing the instructions, all participants signed an informed consent form and were allowed to withdraw at any time. There was no time limit on the sessions. All packets were checked as the subjects left the room. Packets with test sheets incorrectly filled out were not scored.

The treatments consisted of an instructional text describing the function and structure of the human heart. Fifty percent of the subjects received instructions to form specific visual mental images. There were no visual illustrations included in either treatment.

Imagery Instructions. Based on Kulhavy and Swenson (1975), imagery instructions were placed on each page of the treatment booklets for the instructed groups. Imagery instructions were formulated for each page. The instructions told the subject to "Picture in your mind" specific detail described on that page. An example of the instructions on one page is "Try to picture in your mind the heart inside a sac with two walls. The pericardium is on the other wall and the epicardium is on the inner wall."

Shepard and Podgarny (1978) and Bransford et al. (1982) state that specific instructions help ensure better internalization and, thus, better test results. Also,

placing the instructions on each page was rooted in the need to maintain the strategy throughout the treatment. Such a technique was used with general imagery instructions by Kulhavy and Swenson (1975). A post-treatment question was also used to assess the subjects' use of imagery in the experimental situation. This question used a Likert scale and asked if they "formed pictures in their mind" during the task they had just completed. In addition, the subjects recorded the amount of time it took them to read the text passage.

The drawing test comprised a page with list of twenty structures described in the text. Each structure had to be included on the drawing. A point was given for each correctly placed structure on the drawing. A Kuder-Richardson reliability coefficient of 0.839 was calculated for this test.

Results

Analysis of variance on the posttest revealed that the instructed group's mean was significantly higher than the mean of the control group ($F=3.92$, $df=1/108$, $p < 0.05$). Significant positive correlations were also found between the drawing test scores and the use of more time for reading the text (accretion) ($r=0.267$, $p <0.01$), and the drawing test scores and the use of imagery while reading the text ($r=0.253$, $p<0.05$). Thus, the presence of imagery

instructions appears to influence the induction of mental imagery, increased time interacting with the instructional material, and improved performance on a constructional task.

The results of the present study provide evidence that imagery instructions are a valuable strategy for increasing interactions with the instructional material. Some have argued that imagery instructions simply increase interest or motivation (Paivio, 1969). Since time is the "hallmark" of imagery use (Kosslyn, 1980) and drawing from memory requires the generation of a mental image in the working memory, imagery instructions actually induce the use of imagery during learning. Furthermore, it seems that imagery instructions may be important to learning spatial or structural information in an efficient and effective manner.

Conclusions

Although there is no agreement on the existance of a long term visual store, this study appears to support the dual code theory of Paivio (1969) which states that information is processed and stored with both a verbal and non-verbal code. Although the text passage presented no images visually, it did describe a great deal of structural information. Descriptive information in itself is image evoking. However the increased use of concurrent nonverbal

encoding (dual coding) was made further available by the imagery instructions.

The presence of the two codes in memory may have facilitated the more accurate drawings from memory for the instructed group. However it is difficult to account for the effect of imagery instructions, since they arouse verbal mediators, and may increase motivation or interest (Paivio, 1969), and facilitate a better understanding of selective qualities, i.e. the spatial and temporal relationships (Kosslyn, 1988; Paivio, 1976). Although imagery instructions may not ensure use of imagery, the results of the present study indicate that imagery was induced. The improved accuracy of the drawings means that the spatial information, i.e. positions of structures, was preserved better in memory for the instructed subjects due to the use of mental imagery (figures 1 and 2).

Mental images are conceptual interpretations of symbols and patterns that are important parts of mental representations (Finke et al., 1989) and provide a basis for reconstructing more accurate memories (Richardson, 1972). Imagery has long been used as a strategy to represent conceptual problems in architecture, mathematics and other mental synthesis tasks that require mental representations and manipulations of spatial relationships (Antonietti et al., 1985). Based on the results of the present study, the use of mental imagery should be

investigated where important spatial or structural information needs to be learned.

The goal of instructional design theorists is to uncover the cognitive operations used by experts (Aronson & Briggs, 1983). Mental imagery, as a type of physical mental model and specialized type of mental representation (Johnson-Laird, 1983), is one of these operations. The quality of the mental representation is one of the ways novices and experts differ (Chi, Glaser & Rees, 1981; Gilhooly, 1989; Mayer, 1989). Imagery and the new associations promoted by its use can be important in the formation of higher quality mental representations (Kulhavy & Swenson, 1975; Johnson-Laird, 1983) needed by novices.

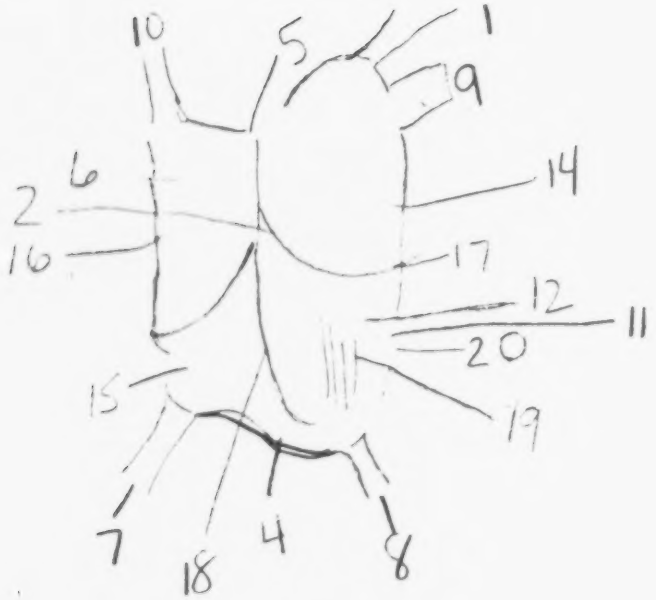
If learners had an awareness of imagery and its function could facilitate the acquisition of expertise in many areas. For example, ultrasound radiographers interpret grey-scale output of tissue echogenicity by imposing their image of human anatomy on the ultrasound image. Making the physician aware of imagery use at the beginning of training may contribute to more effective and efficient training of diagnosticians. Also, imagery instructions and a drawing test could prove to be valuable to ensure that operators of complex control panels know the exact location of important controls.

Although the use of imagery instructions improves constructional task performance, it is not known if

interactions exist between imagery instructions, imagery use, and other instructional variables. Further research is needed to determine whether or not imagery instructions are a viable instructional technique when information containing a considerable amount of spatial information must be mastered.

Drawing test

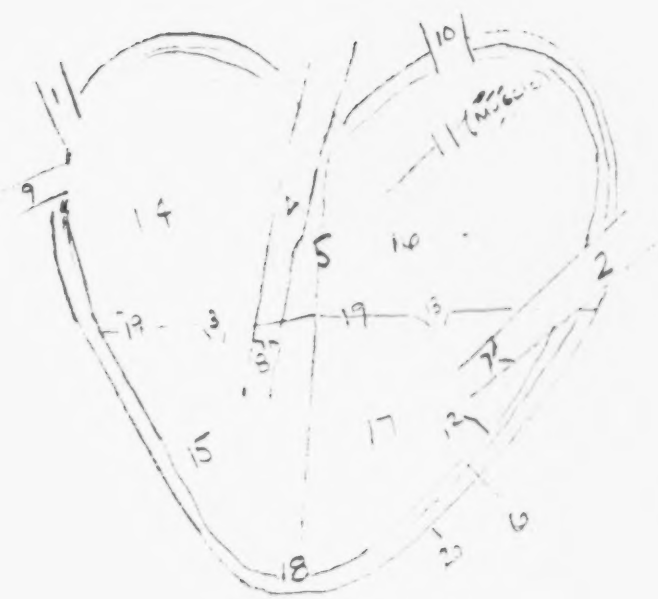
Directions Draw a simple line picture of a heart and place the corresponding number (use the 20 identified parts on the list) where they would be located on the heart



1. Superior Vena Cava
2. Aorta
3. Tricuspid Valve
4. Pulmonary Veins
5. Septum
6. Epicardium
7. Aortic Valve
8. Pulmonary Valve
9. Inferior Vena Cava
10. Pulmonary Artery
11. Myocardium
12. Endocardium
13. Mitral Valve
14. Right Auricle
15. Right Ventricle
16. Left Auricle
17. Left Ventricle
18. Apex
19. Tendons
20. Pericardium

Figure 1. The drawing test of an uninstructed subject.

Directions Draw a simple line picture of a heart and place the corresponding number (use the 20 identified parts on the list) where they would be located on the heart.



1. Superior Vena Cava
2. Aorta
3. Tricuspid Valve
4. Pulmonary Veins
5. Septum
6. Epicardium
7. Aortic Valve
8. Pulmonary Valve
9. Inferior Vena Cava
10. Pulmonary Artery
11. Myocardium
12. Endocardium
13. Mitral Valve
14. Right Auricle
15. Right Ventricle
16. Left Auricle
17. Left Ventricle
18. Apex
19. Tendons
20. Pericardium

Figure 2. The drawing test of an instructed subject.

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